

## I. INTRODUCTION

This manual is prepared to acquaint the Purchaser with basic operation and maintenance of the ENELCO<sup>1</sup> Pulse-Jet Fabric Filter.

Accessory systems which were sold under this contract, but are not part of the baghouse proper have separate operation and maintenance manuals located in the appendix section. Some of the major accessory systems which fall into this category are:

ACCESSORY SYSTEMSMANUFACTURER

Hopper Vibrators	FMC Corporation
Hopper Heaters	Bylin
Hopper Level Indicator	Bindicator
Hoist	Duff-Norton
Pressure Transmitters	Rosemount
Temperature Transmitters	Rosemount
Annunciator	Rodchester Instrument Systems
Programmable Logic Controller	Allen Bradley SLC 500
Chart Recorder	Yokogawa
Weather Enclosure Vent Fan	Cincinnati Fan and Ventilator

- . A general description of these accessory systems is included in Section V of this manual.

The baghouse is an ENELCO<sup>1</sup> Pulse-Jet Fabric Filter Model Number 8 x D240 - 12TD - Top Door Model

Height of Bags (ft.)

Number of Bags per Module

"D" Series = 6" Diameter Pulse-Jet Bags

Number of Modules or Compartments

The baghouse will be shipped in three shop assembled components. These include the modules, the inlet manifold and the outlet manifold. Included in the module assembly are the hopper, housing, walk-in plenum and tube plate. Bags, cages and venturis are shipped separately. Depending on road clearances, the air reservoir and timer panel may also be shipped loose.

The support steel, platforms, railings, safety ladders, vibrators, stair tower, dampers, expansion joints, bypass, hopper heaters, level detectors, control panel and other auxiliary equipment are shipped separately (if supplied).

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## II. SAFETY

Before any work is done on the electrical system, BE SURE ELECTRICAL POWER IS TURNED OFF and that an electrician is sufficiently instructed in the operation and maintenance of this system.

Before the cleaning system is pressurized, be sure all pipe couplings, fittings, and tubing are securely attached.

Before any work is done on the compressed air cleaning system, BE SURE SYSTEM IS DEPRESSURIZED, and that a qualified operator is sufficiently instructed on operation and maintenance of this system.

Before entering a compartment, close all dampers to that respective compartment and physically padlock them in the closed position.

EXTREME CARE MUST BE TAKEN IN OPENING THE ACCESS DOORS! To gain access to the unit, follow the shut down procedures listed in Section V of this manual and permit the air cleaning system to sequence two complete cycles after gas flow is stopped. The dust discharge system (pneumatic, screw conveyors, rotary airlocks and/or double dump valves) should then remain in operation for an hour. When the dust discharge system is deenergized PHYSICALLY LOCK the power source in the OFF POSITION for hopper access.

NOTE: Be sure hopper is empty and residual dust has had adequate time to cool before attempting to open a hopper access door. DO NOT STAND IN FRONT OF DOOR WHEN OPENING IT; stand off to one side and if possible allow door to swing away from the operator. The operator must allow himself an escape path if hot dust streams out, due to internal hopper bridging.

CAUTION: HOT DUST CAN CAUSE SEVERE BURNS!

II-A SAFETY ADDENDUM

When a module is de-energized for maintenance, the microprocessor controller will skip this module; however, the module timers should be switched off to prevent the accidental operation of diaphragm valves or air cylinders.

Do not attempt to block the operation of the poppet valves by wooden or metal props, since an accidental cycling of an air cylinder would cause damage to the poppet and possible personal injury.

The inlet and outlet dampers have mechanical padlocks to lock each damper in the close position. BEFORE ENTERING ANY UNIT MAKE SURE THE PADLOCKS HAVE BEEN INSTALLED.

Before entering a compartment while the remainder of the baghouse is in service, open the top-hatch door and allow approximately 1-2 hours for the heat to dissipate, and lingering fumes and gases to be purged from the module by natural ventilation. Opening the hopper door may help to accelerate this ventilation.

### III. DESCRIPTION OF OPERATION

A basic understanding of the design and operating principles of the ENELCO<sup>1</sup> Pulse-Jet Fabric Filter will be of value in maintaining the collector and optimizing its performance.

#### A. Normal Filtering

The Pulse-Jet Fabric Filter is similar in concept to other fabric filters since it consists of a plurality of circular filter bags housed in a gas tight enclosure with a dust hopper underneath. However, it is unique in that particulate is collected on the outside of the filter bags and compressed air is used to clean the bags.

The bags are fitted over cages to prevent them from collapsing during operation. They are suspended and hang freely from a gas tight tube plate, which separates the clean and dirty sides of the gas stream inside the fabric filter.

This particular baghouse system consists of eight modules. Each module or compartment of bags is interconnected by a gas inlet and gas outlet manifold. Dust laden gas is pulled into the inlet manifold by the fan. The inlet manifold spans the length of the baghouse and ducts the gases through inlet dampers, into the hopper of each module. The gases under suction from the I.D. fan are directed upward by vanes and baffles in the hopper.

Particulate which remains suspended in the gas stream collects on the outside of the filter bags. Clean air is drawn up through the filter bags, which are open at the top, and into the clean gas outlet plenum. Clean gas is then ducted through outlet dampers into the outlet manifold, which as pointed out above is common to all modules. Gases in the outlet manifold are discharged into the customer supplied ductwork, fan and stack.

#### B. Fabric Cleaning

At certain intervals the filter bags undergo cleaning. The bags are cleaned, one row at a time, with a momentary high pressure burst of air from the compressed air system. Each module is supplied with its own compressed air cleaning system. This system is comprised of an air reservoir and a number of diaphragm valves, each provided with a blow pipe which is aligned over a row of bags. The compressed air flows from the reservoir, through the diaphragm valve and into the blow pipe. The compressed air is directed downward through holes in the blowpipe into venturis located at the top of each bag. The venturis increase the cleaning energy applied to each bag.



The operation of the diaphragm valve is controlled by a solenoid valve, while the duration and frequency of energization (on and off times) of the solenoid valve are controlled by an ENELCO<sup>1</sup> Pulse-Jet Fabric Filter Timer. Cleaning can be initiated manually or automatically by differential pressure across the baghouse system.

### C. System Cleaning Cycle

Most types of dust generated from high temperature (above 250°F) process applications will not fall by gravity into the hopper when cleaned from the bags, unless the module is isolated from the gas flow. It is for this reason that only one of the baghouse compartments undergoes cleaning while the remaining compartments are collecting particulate. The compartment being cleaned is isolated from the gas flow. This is known as off-line cleaning. Although this baghouse has the capability to clean compartments on-line, off-line cleaning is recommended to promote longer bag life.

A programmable microprocessor, usually located in the baghouse control panel, sequentially controls the operation of all compartment isolation dampers and timers. The cleaning operation begins with the outlet isolation damper of one compartment closing, preventing further filtering of dust laden gases in that module. A signal is then sent from the microprocessor to the timer which sequentially pulses each row of bags. After all rows are pulsed, a null period allows the dust which has been cleaned from the filter bags to settle into the hopper where it is removed. The outlet damper is then reopened, returning this compartment to service.

Each compartment will be out of service approximately three minutes for cleaning, and the sequence will occur as follows:

<u>OPERATION</u>	<u>TIME (Seconds)</u>	
Close Outlet Damper	10	
Pulse Cleaning	150	
<u>Null Period</u>	<u>30</u>	
Compartment Cleaning Cycle	190	(3.2 Minutes)
<u>Number of Compartments</u>	<u>x 8</u>	
System Cleaning Cycle	1520	(25.3 Minutes)

The times allotted for closing the damper and the null or settling period are programmed into and controlled by the microprocessor. The duration of the pulse cleaning cycle is adjustable at the timer for each specific module.

#### D. Cleaning Controls

A system cleaning cycle can be initiated automatically by either an adjustable cycle time or a system differential pressure signal. Cleaning can also be initiated manually. Controls will allow manual initiation of both a system and individual compartment cleaning cycle.

On an average the baghouse will undergo cleaning every one to two hours, if the system is operating in the demand or automatic cleaning mode. This will vary with cleaning pressure, age of the filter bags and whether the baghouse is operating at full or partial load.

The individual timers of each module will be operated in a sequential manner. The first compartment's timer will be energized by the programmable controller until all the bags in that module have been cleaned. Then the timer will send a signal back to the main controller which will deenergize the first compartment's timer. The main controller will then energize the timer of the second module, repeating the process.

The individual timer, when energized, fires one solenoid valve at a time and in sequence from one end of the collector to the other, and continues this cyclic process until deenergized. Once it is stopped, the timer will always start by continuing in succession from the previously fired valve.

The operating pressure drop can be reduced by one of the following methods:

1. Increase cleaning air pressure at pressure regulator.
2. Initiate cleaning at a lower pressure drop at system pressure recorder.
3. Decrease timer off-time at each individual timer.
4. Increase timer on-time at each individual timer.

These are listed in order of preference for effectiveness. Each has the effect of either increasing cleaning energy or decreasing cycle time.

Cleaning air pressure should be regulated between 50 - 70 psi. Lower pressures will promote longer bag life. Auto or demand cleaning should be initiated between 4" and 5" W.G. Lowering the pressure at which cleaning will start has the effect of

lowering the pressure drop but will also shorten bag life because bags will be cleaned more often.

Decreasing timer off-time (interval between pulses) will shorten the time it takes to clean a module, and therefore, could reduce the overall system pressure drop. However, reducing the interval between pulses too much could result in insufficient pressure in the air reservoir thereby limiting the volume of air to pulse clean the bags. The interval between pulses should be set such that no solenoid valve is energized more than once every one and one-half minutes, otherwise the coil may burn up.

Increasing the timer on-time (pulse duration) will result in an increase in the volume of air to pulse clean the bags. A setting of under .05 seconds will likely result in insufficient cleaning air volume whereas a setting greater than .20 seconds may cause unnecessary consumption of compressed air.

#### E. Baghouse Control Panel

The baghouse control panel contains the control system logic, provided by a programmable controller. The front panel is arranged in a graphic layout. It indicates the status of various modes in which the system is operating and monitors the overall pressure drop. It also allows remote control of the following functions:

1. System start-up or shutdown.
2. Compartment isolation.
3. Manual or Auto cleaning cycle of entire baghouse.
4. Manual cleaning of an individual compartment.
5. On-line or Off-line cleaning.
6. Control of Bypass damper.

Other conditions such as high ash level in the hoppers, high system differential pressure, high inlet temperature and low inlet temperature are also indicated.

The system differential pressure will serve in general as the best indicator of overall baghouse performance. In particular the differential pressure across the individual modules will be the best indicator of the condition of the filter bags. A sudden increase or decrease in pressure drop can mean blinded bags, leaks from holes in the fabric, an inoperative damper, cleaning system malfunction or overfull hoppers. Immediate action is required to isolate and solve the problem and prevent bag failures.

IV. DESIGN CONDITIONS

## A. OPERATING CONDITIONS

Application	Wood Fired Circulation Fluidized Bed
Gas Volume	125,270 ACFM
Temperature	324°F
Inlet Dust Load	2.33 Grains/ACF
Maximum Pressure	+8 to -30" W.G.
Design Temperature	425°F
Minimum Flue Gas Temperature	324°F

## B. BAGHOUSE DESIGN

Type	Pulse-Jet
Size	8 x D240-14TD
Number of Modules	8
Bags Per Module	240
Bag Size	6" diameter x 14' long
Cloth Area Per Module	5,280 square feet
Air To Cloth Ratios:	
Gross	2.97 FPM
Net (1 Module Off-line)	3.39 FPM
Hopper Storage	8 hours

**C. FILTER BAGS**

<b>Material</b>	<b>Woven Fiberglass</b>
<b>Finish</b>	<b>Goretex on Teflon B</b>
<b>Weight</b>	<b>16 ounce/Sq. Yd.</b>
<b>Maximum Temperature</b>	<b>500° F</b>

**D. PERFORMANCE GUARANTEES**

<b>Emissions</b>	<b>0.01 Grains/dscg @ 12% CO<sub>2</sub></b> <b>0.005 Grains/ACF</b>
<b>System Pressure Drop</b>	<b>7.0" W.G. (net)</b>

V. DESCRIPTION OF EQUIPMENT

## A. Modules

The baghouse is comprised of eight individual modules or compartments. These modules provide the needed sectionalization for off-line cleaning and/or maintenance. Each module consists of a hopper, housing, tube plate, outlet plenum with top hatch and compressed air distribution system, and is shipped to the jobsite in one piece. The modules are supplied with corner stub columns for attachment to the support steel. Each module allows thermal growth from a single fixed point at this connection.

## 1. Hopper

Each hopper is fabricated of 1/4" high strength steel. The hopper has two main purposes; one is to serve as the dirty gas inlet into each module, and the other is to funnel collected particulate into the dust removal system. A turning vane and baffle design in each hopper minimizes turbulence and promotes even distribution of gases at the bottom of the bags. A 2' x 2' access door is provided for inspecting each hopper's interior and the bottom of the bags. A 12" diameter discharge flange is provided for connection of hopper to customers dust removal system.

NOTE: The hopper should not be used as a storage area for collected dust as this will be reentrained onto filter bags, causing an excessive pressure drop and premature bag failures. The dust removal system should be operated continuously to avoid heavy buildups of dust in the hopper.

The following is a list of hopper accessories supplied with this baghouse. Each is involved with preventing heavy buildups of dust in the hopper.

- 1.1 (2) 4" diameter poke holes
- 1.2 (1) 6" square strike plate
- 1.3 (1) High ash level alarm
- 1.4 (1) High-high ash level alarm
- 1.5 Low watt density heaters
- 1.6 (1) Hopper Vibrator (External)
- 1.7 (1) 24" Square Access Door



## 2. Housing and Top Door (Hatch)

Each module is furnished with a housing, enclosing the filter bags, and a gas tight, clean air, inspection enclosure over the bags known as a outlet plenum. Both are fabricated of 3/16" A-36 high strength steel. The housing and outlet plenum are separated by a tube plate, to which the bags are mounted. The top door, a 12' x 10' hatch is provided for entry into the outlet plenum. Removal of the hatch provides access to the tube plate for inspection, removal or installation of the bag and cage assemblies. Clean air exits the outlet plenum of each module through the outlet poppet damper and into the outlet manifold.

## 3. Tube Plate

Each tube plate is fabricated of 1/4" A-36 steel. The tube plate separates the clean and dirty sides of the baghouse and serves as a bag inspection platform inside the walk-in plenum, from which the bags are hung. The tube plate bag array is arranged into fifteen rows. Since this module has 240 bags, there will be sixteen bags in each row. The 6" diameter bags have their tube plate holes located on 8" centers. The bag and cage assemblies are inserted through these holes and held in place by their top retainer flange. Venturis, located inside the top of each bag, serve as an aspirator to increase the cleaning energy applied into each bag, and reduce the compressed air requirements.

## 4. Compressed Air Distribution System

Included in this system are the air reservoir, solenoid actuated diaphragm valves, and the pulse pipes. The timer panel, discussed under Electrical Controls in Section VI, is shipped prewired to the solenoid valves and mounted on the air reservoir. A single pulse pipe is positioned over each row of bags and connected to the fifteen gallon air reservoir via a solenoid actuated diaphragm valve. The amount of compressed air delivered to the bags is a function of air pressure inside the reservoir and the length of time the diaphragm valve remains open. A pressure regulator on each air reservoir is used to indicate and control air pressure within the reservoir.

Quick response time is achieved by the use of 1-1/2" double diaphragm valves. Compressed air inside the air reservoir pressurizes both sides of the trigger diaphragm and the main diaphragm, holding the valve in the closed position. Upon energization of a solenoid valve, a pressure differential is caused across the trigger diaphragm. The diaphragm then

lifts, allowing air to be vented from one side of the main diaphragm. The induced pressure differential across the main diaphragm causes it to be lifted and admit air to the pulse pipe which directs air to the bags via the venturi tube. The air quickly fills the bags causing the bag material to expand. This sudden acceleration of the bag from the cage followed by deceleration causes the accumulated dust cake to separate from the outside of the bag. Deenergization of the solenoid valve closes the atmospheric vent and allows air pressure to close the diaphragm valve.

#### 5. Access Doors

Due to the high degree of sectionalization within the baghouse, and the subsequent need for access into each section or compartment, in-leakage and corrosion can be a potential problem as a result of the large number of penetrations. The solution is two-fold. First, the ENELCO<sup>4</sup> top door (hatch) minimizes the number of penetrations by providing a full height, gas tight enclosure over the tube plate with a single 12' x 10' access door for entry, rather than a large number of small hatches in the roof through which the bags are removed.

Secondly, the design of the door reduces the possibility of premature gasket failures, not by using an exotic material which is resistant to corrosion, but by designing a door that does not leak. The door itself is fabricated from 3/16" plate and the stiffness of this plate lends itself to more consistent sealing. The gasket is attached not to the door, but to the coaming using 1/4"-20 bolts and fender washers; and therefore, will always seal against the flat surface of the door, regardless of alignment.

Each hopper is provided with a single access door. These doors are 2' x 2' and include a safety chain to prevent accidental full opening in the event they are covered by dust.

#### B. Filter Bag and Cages

Each module contains 240 bags, each 6" diameter and 14'0" long. The bag material is woven fiberglass with a Goretex on Teflon B finish. The fabric weight is 16.0 ounces per square yard. A 2" wear cuff at the bottom of the bags prevents premature failure caused by bag to bag abrasion. Support for the bags is provided by wire cages which are inserted into each bag.



Because of the need to minimize excessive flexing of the fiberglass yarns, strict quality control procedures are used to insure a tight fit between bag and cage. In addition to this, the cage has narrow openings, thus providing greater support for the fabric. The wires which form the primary support are oriented vertically. These wires are spaced less than an inch apart, yet due to their vertical orientation and galvanized finish, the snug fitting bags slip on and off with relative ease. To provide adequate rigidity, the cages are constructed of 12 gauge wires with annular rings spaced on 8" centers.

The bags are removed and installed from the clean air outlet plenum. There is no need to enter the dirty side of the baghouse to replace bags. Once the pulse pipes are disconnected, each bag and cage assembly is inserted through an opening in the tube plate and retained by its top flange. The force required to seal the bag flange against the tube plate is accomplished by aligning and bolting the venturis into place. Weld studs with integral wingnuts are provided on the tube plate for this purpose.

Once the venturis are inserted and positioned against the studs, simple hand tightening of the wingnuts forces the cage flange onto the fabric flange which in turn seals against the tube plate. The rigid flange of the cage in conjunction with the retainer ring within the bag flange provides uniform sealing and positive alignment. Moreover, the stainless steel studs are unaffected by the potentially corrosive environment. Removal of the assembly is made easier by slots in the venturi flange. Once the wingnuts are loosened, the venturis need only be rotated to be removed.

#### C. Inlet and Outlet Manifolds

The inlet and outlet manifolds distribute the gases into and out of each individual module. The manifolds are centrally located between the two rows of modules and connected to each by an isolation damper. The design of these manifolds and gas passages used in Environmental Elements baghouses are based on 35 years of field and flow model experience. The gas passages and manifolds have been designed to optimize the following essential criteria:

1. Minimize plenum, compartment damper and system pressure drop.
2. Balance flow and dust distribution between compartments and between filter bags within a compartment.

3. Minimize the potential for dust dropout in the inlet manifold.

These objectives have been ensured by these key design features: a stepped inlet manifold, multiple turning vanes in each elbow, low gas velocities at critical transitions and a system of turning vanes and baffles in each hopper.

#### D. Compartment Dampers

Isolation dampers are located at the gas inlet and outlet to each module. At the inlet, butterfly dampers are used and poppet type dampers are used at the outlet. Leakage results and life cycle tests have been documented for both types during optimization of component design.

##### 1. Poppet Dampers

The baghouse is designed to normally operate under negative pressure, i.e. less than atmospheric pressure, and under these conditions when a module or compartment is isolated, the damper closest to the I.D. fan is closed. Since this is the only damper that closes during off-line compartment cleaning, poppet dampers are used at this location. These dampers are selected for their low leakage characteristics.

This damper consists of a flat, circular plate, or blade, connected to a shaft. The shaft is either raised or lowered to open or close the damper. In the closed position, the blade is seated against an opening in the duct work. The duct opening is fitted with a raised collar onto which the circular blade seals.

The damper actuator provides enough force to cause a deflection of the blade as it seats around the collar, similar to the action of a diaphragm seal. The blade must be flexible enough to provide a uniform metal to metal seal, yet not allow permanent deformation. A guide bar provides alignment of the poppet shaft and prevents rotation of the blade, thereby allowing consistent sealing after repeated use. A machined packing gland is used to seal the poppet shaft at the point where it penetrates the duct wall.

A shop installed, double acting air cylinder provides the force necessary to open and close the damper. The air cylinder is actuated by a dual, four way solenoid valve, and the position of the damper is indicated by limit switches. The air cylinder is mounted on a pedestal

support with oversized handholes for easy access during maintenance. A pin and lock assembly is used to mechanically lock the damper in the closed position for on-line maintenance.

## 2. Butterfly Dampers

Butterfly dampers are used, instead of poppet dampers, at the inlet of each compartment. Leakage is not as critical through this damper, since during compartment isolation, the poppet damper at the module outlet will also be closed. Therefore, the primary concern is to utilize a damper that exhibits good pressure drop characteristics and functions well in a dirty gas stream. The capability of vaning the manifold turn preceding the damper along with the advantage that the gases do not transition in cross sectional area when entering or leaving this damper make it the perfect selection to be integrated into the ENELCO<sup>1</sup> Stepped Inlet Manifold.

Nevertheless, several design features are incorporated into the ENELCO<sup>1</sup> Butterfly Inlet Dampers to minimize leakage and corrosion. Spring type blade seals fabricated of stainless steel are installed around the perimeter of the damper frame. The damper shaft is also stainless steel with a sleeve type shaft support on both ends which is welded gas tight and sealed with v-ring seals.

A shop installed, rotary action pneumatic actuator provides the necessary torque to open and close the damper. Similar to the poppet damper, a dual, four way solenoid valve and limit switches are included to control the air actuator and indicate damper position, respectively. This damper can also be mechanically locked in the closed position to assure safety during maintenance periods.

## E. Bypass System

A bypass system is supplied to divert flue gases away from the compartments during conditions which may cause premature bag failure. The bypass is normally used during start-up and high temperature excursions above 500°F, but can be used during high and low differential pressure upsets. The system consists of one or two round sections of ductwork depending on the amount of gas to be bypassed, and poppet dampers to isolate these sections during normal operation.

The bypass duct provides a direct path from the inlet to the outlet manifold, thereby short circuiting around the filter bags. It is designed for automatic operation and furnished with a manual override. The bypass system is sized to simulate the pressure drop caused by the filter bags even though they are out of service. This prevents large variations in the operating pressure, thereby causing an upset in boiler draft.

#### F. Insulation and Lagging

Insulation and lagging is applied to all hot surfaces including module housing, top door hatch, hopper, inlet and outlet manifolds. Details of the design are as follows:

##### Insulation

Material	Fiberglass-Rigid Board
Thickness	4"

##### Lagging

Material	Stucco Embossed Aluminum
Style	Box Rib
Thickness	0.04"

Installation Method	Conventional
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Insulation is installed over all stiffeners and the lagging will be attached to aluminum subgirts. Flue stops are installed on 5'0" centers on all vertical walls.

#### G. Hopper Heaters

Manufacturer	Bylin
Type	Low Watt Density
Total Heating Load	5.2 KW per Hopper
Design Voltage	480 VAC/3 Phase
Junction Box	NEMA 4
Temperature Detector	Bulb and capillary thermostat

#### H. Hopper Heater Control Panels

Quantity	Eight
Enclosure	NEMA 4
Temperature Controllers	Bulb and capillary thermostat

The hopper heaters are designed to maintain the lower 1/3 of the hopper surface area at 250°F. The temperature controllers should be set at this temperature. The heaters will be energized whenever the temperature falls below this point.

Controls for the hopper heaters are housed in a single enclosure for each hopper. Included in the enclosure are contacts for the heaters and contacts for the low hopper temperature alarm. Power for each enclosure is feed through the customer's motor control center.

#### I. Hopper Level Indicator

Quantity	Two Per Hopper
Purpose	Detect High Hopper Ash Level and High-High Hopper Ash Level
Manufacturer	Bindicator
Model	10000 Series including probe, conduit and remote enclosure
Type	Radio Frequency Capacitance
Output Relays	DP/DT
Current	120 VAC
Power	3 Watts
Maximum Probe Temperature	500°F

VI. ELECTRICAL CONTROLS

## A. Timer and Solenoid Valves

## 1. Electrical Circuit Description

Each ENELCO Pulse-Jet module electrical circuitry consists of two major components: a timer and fifteen solenoid valves (one for each row of bags). The solenoids will be mounted integrally to the diaphragm valves and prewired to the timer. The timer is mounted in a NEMA 4 panel with a face mounted magnehelic gage and the panel is in turn mounted on the compressed air reservoir.

The timer supplied with the fabric filter is a National Controls Corporation programmable timer. It is of solid state construction with integrated circuits used for maximum reliability. It offers an adjustable pulse duration of 50-500 milliseconds and interval times between pulses of 8-180 seconds. These are known as on and off times, respectively. The timer is rated for operation at ambient temperatures between -20°F to 130°F and an input power supply of 105-136 VAC and 50-60 Hz.

The solenoid coils are rated for 0.63A in rush, 0.46A holding at 120 volts and are encapsulated and provided with screw terminals for connection of the valves to the electrical signal wire from the timer.

When input power is connected to the timer via terminals L1 and L2, the timer is energized at all times and will operate continuously unless power is interrupted on the input power line or by a pressure switch connected to the "Pressure Switch" terminals. The pressure switch terminals are wired back to the microprocessor in the main control panel. A photohelic gage or a selector switch on the control panel sends a signal to the microprocessor to energize a timer. The microprocessor energizes the timer as a result of a differential pressure signal from the photohelic gage or a manual override initiated at the main baghouse control panel.

A manual "ON-OFF" switch is provided on the input power line to the timer. As soon as the timer is energized the preset "OFF" time is initiated. At the end of the "OFF" time, the control will energize a solenoid for the preset "ON" time and then shift to the next output and start a new present "OFF" time cycle.

## 2. Timer Operating Instructions

The timer should be wired in accordance with wiring diagrams supplied with this manual. The wiring procedure entails running input power wires to the timer plus control wires between the timer and baghouse control panel.

For grounded systems the neutral of "LINE" must be connected to terminal L2.

Actual operation of the timer involves the following sequence:

- 2.1 A model DNC-T2020-B10 timer is supplied with this ENELCO<sup>1</sup> Pulse-Jet Fabric Filter.

To program this model, terminate the wires from the solenoids to the respective point on the timer board. If fewer than the total output capacity is needed, attach the program wire plug (on timer board) to the last output required. This plug will be sent from the factory connected to the last output.

Failure of a solenoid valve, or connecting the program wire to a pin corresponding to a number of outputs smaller or larger than that required, will not affect the operation of the timer.

- 2.2 Preset "OFF" and "ON" times with a screw driver on the pertinent timer dials. The preset times should be in accordance with the instructions given in Section VIII, "INSTALLATION AND CHECK-OUT" under Items E.3.1 and E.3.2 in this manual.
- 2.3 The control panel allows for automatic cleaning with a signal from the microprocessor. The cleaning cycle is initiated by the system pressure drop, manual request or timed cleaning signal.
- 2.4 Energize "LINE" power to the timer by turning switch on. If the unit has been properly wired, the "POWER ON" light should be energized on the timer board.
- 2.5 Since the installation allows for automatic, on demand cleaning initiated by the system pressure transducer, the timer will not send a controlled output until the present high differential pressure set point is obtained. However, to check individual timers from module to module a jumper should be installed across the "Pressure Switch" terminals on the timers. This



will cause timer to operate continuously. After checking out the timer remove the jumper.

- 2.6 Once the fabric filter is operating in the desired pressure drop range, you may adjust the "OFF" and "ON" times. It is suggested that the "ON" and "OFF" times be locked in via the lock nuts provided on the indicating dials, to prevent drift from the desired values because of vibration or impact.

### 3. Precautions For Timer

Although the timer board and solenoid coils are fairly rugged and protected, care should be exercised in their handling to prevent damage through physical abuse and incorrect wiring.

The following precautions should be observed during installation:

- 3.1 Before connecting power to the solenoid timer board it should be ascertained that the power source is compatible with the timer characteristics, namely 105-135 VAC and 50-60 Hz, and for grounded systems the neutral side of the line should be connected to terminal L2.
- 3.2 Do not admit input power to the timer board until all wiring has been completed. Make sure that all terminals are screwed tightly and that the solenoid common wire is not in electrical contact with any timer output wires.
- 3.3 If pressure switch operation is not desired, make sure that the control contacts are wired closed, i.e., the factory installed metal jumper is in place. Conversely, if automatic switch operation is desired, the jumper should be removed.
- 3.4 Make sure that the timer program wire is connected to the output pin (No. 15) corresponding to the last solenoid valve in the train.
- 3.5 Do not use a preset "OFF" time that will result in any one solenoid valve firing twice in less than 1.5 minutes since this may damage the coils. Therefore "OFF" times of 6.5 seconds or greater should be used.
- 3.6 Do not disconnect any solenoid valve for maintenance or repairs without disconnecting the input power first. The same applies to the differential pressure switch



terminals. A manual "ON-OFF" switch is provided on the front of the timer panel for this purpose.

#### B. Baghouse Control Panel

The logic of the baghouse control system is provided by a programmable controller, and is housed in a free standing NEMA 12 enclosure.

The Digital Control System allows the baghouse to be operated either manually or automatically. Start-up and shutdown of the entire baghouse or any individual module can be accomplished from the control panel.

The system pressure drop is monitored at this panel as well as the status of various baghouse operating modes. The latter is represented by a graphic display of lights and switches, which also serve to indicate alarm conditions.

Instructions for operation and description of its capabilities are as follows:

##### 1. Baghouse "ON-OFF" Switch:

- 1.1 OFF - Opens the Bypass damper and closes all baghouse compartment dampers, after a three second delay. Continually energizes damper solenoids in the open/closed position, unless the main breaker is off. Also resets internal twelve hour timer.
- 1.2 ON - Opens all baghouse compartment dampers, after a two second delay, except the dampers on the compartments which have been closed manually by the appropriate module isolation ("Open-Auto-Close") switch.

Indicating lights signal the position of this switch ("ON-OFF").

- 2. System Delta P - The chart recorder displays operating draft loss across the entire baghouse system. Lower and upper setpoints allow adjustment to cleaning cycle initiation (for the auto cleaning cycle) and to high system differential pressure alarm point, respectively. This alarm point is the differential pressure at which the high Delta P alarm is annunciated.
- 3. System Cleaning Light - Signals when entire baghouse is operating in a cleaning cycle.

4. System High Delta P Alarm - Signals when baghouse system draft loss is too high. This signal is initiated by the high setpoint in (2) above.
5. "Open-Auto-Close" Damper Control Switch - One per module:
  - 5.1 Open - Manually opens both the inlet and outlet damper on an individual module. These dampers will not close during a cleaning cycle. Damper solenoids will be continuously energized in the Open position.
  - 5.2 Close - Manually closes both the inlet and outlet damper on an individual module. This module is essentially out of service and will be skipped during a system cleaning cycle. This module can, however, be cleaned by the "Clean Individual Module" Switch. Damper solenoids will be continuously energized in the closed position.  
**NOTE: DO NOT CLOSE MODULE DAMPERS WHEN THE BY-PASS DAMPER IS CLOSED.** This will initiate a boiler trip and high differential pressure alarm. A fail safe circuit will open the bypass if more than 60% of the baghouse is shutdown.
  - 5.3 Auto - This switch opens the inlet and outlet dampers of an individual module, and places that module in an automatic mode, awaiting an input signal from the microprocessor. In the auto position this module will be cleaned as part of a system cleaning cycle initiated by either differential pressure, the internal timer, or the system cleaning cycle ("Reset-Auto-Manual") Switch when in manual.

In the auto position a module can also be cleaned by a manual command from the "Clean Individual Module" Switch. When switched to auto the damper solenoids of that module are energized temporarily in the open position - long enough to open the dampers.
6. Module Cleaning Light - One Per Module - Signals when an individual module is being cleaned either as part of a system cleaning cycle in auto or manual modes, or as an individual module in a manual mode.
7. Damper Position Lights - Four Per Module - Indicates open and closed positions for both the inlet and outlet

dampers of each module. Remember, it takes approximately ten seconds for the damper to assume a fully open or fully closed position.

8. System Cleaning Cycle: "Reset-Auto-Manual":

- 8.1 Reset - Stops system cleaning cycle whether it was initiated automatically or manually, and opens all dampers that have not been closed manually after a two second delay. There is a spring return from reset to auto.
- 8.2 Auto - System Cleaning cycle will be initiated by differential pressure or by the internal timer. The entire baghouse, one module at a time, will clean for one cycle only, unless system differential pressure is still above the set point initiation on the chart recorder, at the end of the cleaning cycle.
- 8.3 Manual - System Cleaning cycle will be initiated manually. The entire baghouse, one module at a time, will clean continuously while switch is in manual position.

9. System Cleaning Cycle: "OFF LINE-ON LINE":

- 9.1 OFF-LINE - During a system cleaning cycle each module will be cleaned off-line, by closing the outlet damper for that compartment. NOTE: The inlet damper remains open during an off-line cleaning system cleaning cycle.
- 9.2 ON-LINE - During a system cleaning cycle each module will be cleaned on line and will not be isolated by closing the outlet damper.

NOTE: If this switch is changed during a system cleaning cycle, the module presently undergoing cleaning will not be affected, but the subsequent modules will be cleaned based on the new position of the switch.

This switch affects only the modules being cleaned during a system cleaning cycle and has no effect on the outlet damper of an individual module being cleaned manually.

- 10. Clean Individual Module - A "BCD" Switch with nine (9) positions numbered from 0-9. When switched to the appropriate module number, 1-8, the timer for that particular module will be energized, and that module will

clean continually until another position is selected. A five second time delay is allowed before cleaning is initiated. This switch has no effect when in the "0" or "9" positions.

In order to clean an individual module off-line, the "Open-Auto-Close" Switch for the appropriate module must be switched to the Close position, or else it will clean on-line.

If an individual module is being cleaned manually while the baghouse system is operating in a system cleaning cycle, the individual module being cleaned manually will be skipped by the system cleaning cycle.

#### 11. System High/Low Temperature Alarms

Signals when temperature of the flue gas at the inlet to the baghouse is either too high (above 500°F) or too low (below 250°F). These signals are initiated by two temperature set points from the chart recorder which monitor thermocouples in the baghouse inlet manifold.

#### 12. Module High Ash Level Alarms - One Per Module

Signals when level of ash collected in the hopper is too high. This signal is initiated by a Hopper Level Indicator Switch, located at a predetermined level in each baghouse hopper.

#### 13. Clean Cycle Timer Set Switch

This switch sets the internal timer, discussed previously. If the baghouse has not gone through a cleaning cycle within the time indicated by the set switch (1-19 Hours), a system cleaning cycle will be initiated automatically. This timer is reset whenever the baghouse undergoes a system cleaning cycle, but not when an individual module is cleaned.

#### 14. "Open-Auto" Bypass Damper Switch:

14.1 Open - Manually opens the Bypass damper. Damper solenoids will be continuously energized in the Open position. Module dampers are unaffected by this switch. They must be closed manually if this is desired.

- 14.2 Auto - This switch closes the Bypass damper if it is in the open position, and places the damper in an automatic mode, awaiting an input signal from the microprocessor. In the auto position, this damper will open on a high temperature signal (above 500°F) from the temperature switch. It will close when the flue gas temperature at the inlet to the baghouse falls below this setpoint.

The module dampers are interlocked such that on a high temperature excursion, once the Bypass damper opens, the dampers at the inlet and outlet of each module will close. Likewise, when the flue gas inlet temperature falls below the High Temperature setpoint, the module dampers will reopen. Once these dampers are fully open, the Bypass damper will close. The High Temperature signal is initiated by the temperature switch located at the baghouse inlet.

Indicating lights are used to signal the position (open/closed) of these dampers. The chart recorder records any opening of these dampers.

#### 15. Model Temperature Selector Switch

This switch selects any of the 8 modules to be indicated on the module temperature indicator.

#### C. Baghouse Control Panel Logic

An Allen Bradley PLC programmable controller or microprocessor controls all baghouse functions including start-up, shutdown, cleaning, dust collection and removal. A low battery power light is provided on the microprocessor, and should be checked once a year. The battery should be replaced when the light comes on.

Any modifications to the circuits or logic must be performed by Environmental Elements' personnel during the guarantee periods. Modifications performed by other individuals during this period will void the guarantees supplied by Environmental Elements, unless written approval is specifically granted.

#### D. Baghouse Control Panel - Typical Start-Up Sequence

The start-up of the baghouse control panel should be as follows:

1. The "Baghouse ON-OFF" Switch should already be in the off position.
2. The system pressure setpoints and the cleaning cycle timer set switch should be set as specified in Section VIII, "INSTALLATION AND CHECK-OUT" of this manual.
3. The system cleaning cycle switches should be in the following positions:
  - 3.1 "Reset-Auto-Manual" Switch should be in the auto position.
  - 3.2 "On-Line - Off-Line" Switch should be in the off-line position.
  - 3.3 The Clean Individual Module Switch should be set to the "0" position.
4. Turn the damper control switches "Open-Auto-Close" for each module to the auto position. Turn the Bypass Damper "Open-Auto" Control Switch to the auto position. If the baghouse will be bypassed during start-up, refer to the correct procedures in Section IX.B.

**NOTE:** Failure of the appropriate indicating lights to come on is evidence of an equipment failure (solenoids, limit switches, air cylinders, dampers, etc.). These failures must not be ignored, and must be corrected as soon as possible. Operation with these failures for an extended period of time can cause high pressure losses across the fabric and failure of the fabric.

5. Turn "Baghouse ON-OFF" Switch on.

All compartment dampers should open, and the Bypass damper will close.

The baghouse will now operate in the automatic mode and will clean, off-line, when either the system pressure drop reaches the cleaning initiation setpoint or twelve hours, whichever comes first.

#### E. Baghouse Control Panel - Typical Shutdown Sequence

The shutdown procedure for the baghouse control panel should be as follows:

1. As soon as gas has stopped entering the baghouse, allow sufficient time for ventilation of lingering gases within the modules.
2. Turn the system cleaning cycle "Reset-Auto-Manual" Switch to the manual position. This will initiate a cleaning cycle. Allow at least two complete cycles to occur before returning switch to Auto.
3. Allow the dust removal system to remove all accumulated dust from the hoppers.
4. Turn the "Baghouse Control" switch ("ON-OFF") to the off position.
5. The Bypass damper should open after which all compartment dampers will close.

## VII. INSTRUMENTATION

This section will describe the instrumentation which is supplied for the proper operation of the baghouse. The actual calibration and maintenance of this instrumentation should be as recommended by the equipment manufacturer's instruction manuals in Section XII, "APPENDIX".

### A. Module Differential Pressure Indicator

A Dwyer Magnehelic Gage #2010, Series 2000 is supplied for this purpose. Eight magnehelics are supplied (one for each module) and are mounted on the module timer control panel. They are used to indicate pressure loss across a module.

### B. System Differential Pressure Transducer

A Rosemount Differential Pressure Transmitter CAT No. 1151DP3E12B3 is supplied for this purpose. It is used to send a 4-20 mA signal to the chart recorder indicating the pressure drop across the system. The chart recorder then sends a signal to the Allen Bradley Programmable Controller to initiate a cleaning cycle, and to the Annunciator, to alarm a high system pressure drop.

### C. Air Reservoir Pressure Regulator

A Norgren air regulator, Model #R-17-B01-RGLA with 0-160 psi pressure gage is supplied for this purpose. Eight are supplied (one per module) to regulate and indicate air pressure at each reservoir.

### D. Module Timer

A National Controls Model DNC-T2020-B10 is supplied for this purpose. This timer is energized by the programmable controller and sends a signal to each solenoid valve which vents the diaphragm valves to clean the bags. One timer is supplied for each module.

### E. Diaphragm Solenoid

Goyen Integral Solenoids (15 per module) Part Number RCA-5D2 with 1/4" NPT ports are supplied for this purpose, 120 volts - 60 Hz.

During the cleaning cycle, each solenoid is individually energized, thereby opening the diaphragm valve and allowing compressed air into each pulse pipe.



#### F. Inlet, Outlet and Bypass Damper Solenoids

Versa Valve Company Model Number KGG-4232-3TC, four way dual solenoid valves are supplied for each damper actuator with manual positioner, 3/8" NPT ports, 1/2" conduit hub, 115 VAC - 60 Hz.

This solenoid has two coils. One coil when energized will open the damper while the other coil when energized will close the damper. The signal to operate the coils comes from the programmable controller. Also included is a 3/8" M.N.P.T. needle valve to control the actuator speed. This valve is 4" "MEAD" model no. MMS 375.

#### G. Limit Switches

Open and closed limit switches are mounted to each inlet and outlet damper actuator. Outlet dampers and Bypass dampers are supplied with four (4) Lin-Act model L-10 S.P.S.T. Limit Switches rated NEMA 4, .5 amp, 115 VAC - 60 Hz.

Outlet butterfly dampers are supplied with one (1) Bettiswitch model 3R-021-AFC S.P.D.T. Limit Switches rated 10 amp at 115 VAC, NEMA 4. The opening or closing of a damper closes the switch, which then energizes a status light (open/closed) on the main control panel.

#### H. Hopper Level Indicators

Sixteen (16) Level Alarms are supplied, two per hopper. The alarms are Radio Frequency Capacitance type, Bindicator model RF-10000 rated 3 watts at 120 VAC. D.P.D.T. Alarm contacts open when the ash in any hopper reaches the height of the probe, indicating either high or high-high ash level.

#### I. Thermocouples

Two (2) Type J "Thermoelectric" Thermocouples are provided in both the inlet and the outlet manifolds. They are used to give an average temperature to the temperature transmitters.

#### J. Hopper Heater Controllers

Eight (8) "Chromalox" temperature controllers model AR-515 PCN-277958 are used to control each module's hopper heaters. Eight (8) of the above controllers also control the low hopper temperature alarms.

#### K. Inlet/Outlet Temperature Transmitter

A Rosemount temperature transmitter Cat. No. 444TJ1U1A2NA is supplied for this purpose. It sends a 4-20 Ma signal to the chart recorder, which indicates the inlet/outlet temperature. The chart recorder then sends a signal to the Allen Bradley programmable controller to initiate a high temperature alarm.

VIII. INSTALLATION AND CHECK-OUT

The erection and welding procedure of an ENELCO<sup>1</sup> Pulse-Jet Fabric Filter will be as specified in the erection drawings and specifications. See these drawings for details of erection for the structural steel, modules, inlet and outlet manifolds, access facilities, dampers, expansion joints, bag installation and auxiliary equipment.

- A. Upon completion of all leak testing and field welding, proceed to install the bags, cages and venturi tubes. The following procedure is recommended:
  1. Disconnect all blow pipes within a collector module.
  2. Remove the protective wrapping from the bags and gently insert the bags (closed end first) through the holes in the tube sheets; the bag flanges will prevent the bag from dropping through the tube sheet hole.
  3. Insert the bag cages inside the bags and gently guide the cage down until the cage flange rests on top of the bag flange.
  4. Center the venturi tubes inside the cage with tube sheet studs through the mounting holes in the ears. Insert integral washers and wing nuts over the studs and hand tighten nuts. Do not over tighten.
  5. Check alignment of the bags from the inside of the hopper; if clusters of bags touching one another are evident, rotate bags to break the clusters.
  6. Repeat above steps for all collector modules; tighten all wing nuts, and reinstall blow pipes.
  7. Check alignment of all blow pipes.
- B. Install a pressure regulator at the air reservoir of each baghouse module by connecting it to the 1-1/2" MNPT connection on the end of the reservoir. Connect air piping from the compressor or compressed air main to the 1-1/2" FNPT connection on the pressure regulator. Connect air piping to the damper actuator solenoids.
- C. The timer control panel mounted outside each module must be connected to a 115 VAC power supply. The main control panel, located remotely from the baghouse proper, must also be connected to a 115 VAC power supply. All control wiring between the control panel and equipment located at the baghouse [i.e. timer control panels, damper limit switches and solenoids,

hopper heaters (480V), level alarms, vibrators, thermocouples, temperature switches and any other accessory equipment supplied under this contract] must also be field installed.

- D. Install tubing between pressure taps in the manifolds and the pressure indicator or transducer. Tubing must also be installed between the pressure-taps in the module and its respective magnehelic gage located in the timer control panel.
- E. A final inspection of the collector and its components should be made to insure that everything is in operating condition. The following is a suggested check list:
  - 1. Check the inside of the collector (hopper and tube plate) for accumulated water and foreign objects.
  - 2. Make sure the bags, cages and venturis are securely fastened to the tube plate and are aligned properly such that clusters of bags inhibiting upward gas flow are not allowed to exist.
  - 3. Check the gasketing in all access doors.
  - 4. Check all the tubing and fittings for tightness.
  - 5. Recheck the electrical wiring hook-up.
  - 6. Turn on the compressor or air from the compressed air main supply and blow any moisture and foreign objects through the header drain cock. The air supply must be filtered and dried. Check the air pressure gage located on air reservoir to make certain that adequate pressure is available (80-100 psi). Inspect all pipe fittings to insure that everything is air-tight; it may be necessary to tighten some of the fittings.
  - 7. Turn the ENELCO<sup>1</sup> Pulse-Jet Timer on. Check if all solenoid valves and diaphragm valves are operating properly. Adjust the timer for each module to the following settings:
    - 7.1 Interval between pulses - 10 seconds (off time).
    - 7.2 Duration of each pulse - .10 seconds (on time).
    - 7.3 Make sure the differential pressure gage located in the timer panel is reading zero with both vent valves closed. If not, re-zero the gage and then open vent valves.
  - 8. If a system photohelic gage or recorder is supplied with the control panel, adjust the set points as follows:

- 8.1 Low set point - 4.5 inches W.G. to initiate cleaning.
  - 8.2 High set point - 8.0 inches W.G. to energize high Delta P Alarm.
  - 8.3 Make sure the photohelic gage or recorder is reading zero with both vent valves closed. If not re-zero the gage and then open vent valves.
9. Regulate pressure at each reservoir to 50 psi. In no case should air pressure exceed 80 psi without first consulting Environmental Elements Corporation.
  10. Check if module inlet and outlet dampers are operating properly. Adjust open and close times to approximately 10 seconds. Open and close times are regulated by the speed control valve on the exhaust port of the air cylinder solenoid valve.
  11. Adjust the limit switches on each damper so that the full open and full closed positions of each damper are indicated at the main control panel.
  12. Check all selector switches and indicating lights on the main control panel for proper operation and physically check all remote inputs (timers, dampers, etc.) to the control panel for positive assurance of proper operation.
  13. The baghouse control panel should have its selector switches initially set to the following positions:
    - 13.1 Baghouse "ON-OFF" Switch set in the OFF position.
    - 13.2 Each of the eight (8) module isolation switches should be set in the AUTO position.
    - 13.3 The Bypass Damper "Open-Auto" Control Switch should be set in the Auto position. If the Baghouse will be bypassed during start-up, refer to the correct procedures in Section IX.B.
    - 13.4 The baghouse cleaning cycle should be set to the AUTO and OFF-LINE positions.
    - 13.5 The switch to manually clean an individual module should be set to the "0" position.
    - 13.6 The cleaning cycle timer set switch should be set at twelve (12) hours.

IX. START-UP AND SHUTDOWN

The following start-up sequence is recommended as a standard procedure for all fabric filter applications and may be modified as noted to suit the particular needs of any specific installation.

Before start-up of the unit, Section VI "CONTROLS" and Section VIII "INSTALLATION AND CHECK-OUT" should be read and all equipment adjusted accordingly for proper operation.

Be sure to read the "SAFETY" Section of this manual, Section II before opening any access doors.

## A. Start Up - General Guidelines

1. Physically check that all access doors and panels are secured in position.
2. If hopper heaters are supplied, they should be energized at least eight (8) hours before start-up.
3. Start up the compressor or compressed air flow from main supply. If more than one compressor and dryers are installed be sure to check the valving orientation of the compressors and dryers.
4. Turn on the timers at each individual module.
5. Energize baghouse control panel by turning Main Switch "ON". If dust removal systems (conveyors, dust valves, etc.) are not interlocked with baghouse on/off switch, then start this equipment also at this time. Refer to instruction for operation of this control panel in Section VI, Item B.
6. Start up the fan.
7. It is important for the baghouse to be raised to normal operating temperature as fast as possible to minimize condensation of gases on surfaces, particularly the bags, which may be below dew point temperature. Note that in applications involving hot gases from kilns, dryers, etc., the baghouse inlet temperature should be a minimum of 50°F above water and/or acid dew point, whichever is higher, before the feed material is admitted to the kiln or dryer. This has the effect of raising the dew point temperature and possibly blinding the bags.
8. On kilns which are fired with coal and/or fuel oil, unless the baghouse is bypassed at start-up it is important to achieve good combustion initially. If this does not occur, the bags

may be coated with oil mist, condensible hydrocarbons, unburnt carbon carryover, etc. and possibly blinded. On baghouses which are not bypassed or precoated at start-up it is recommended that the bags not be cleaned until oil firing has stopped and baghouse outlet temperature is above the dew point.

## B. Start Up - Coal Fired Boilers

There are two start-up conditions. Initial start-up with new bags which have no dust cake for protection and No. 2, start-up with bags which have been in service and conditioned with a dust cake.

### 1. New Bags

It is recommended that Natural Gas (first choice) or No. 2 fuel oil (second choice) be used as start-up fuel for the boiler. When natural gas or No. 2 fuel oil are used for start-up, the procedures for new bags are as follows:

- 1.1 Turn on all hopper heaters at least eight hours before start-up of the fabric filter.
- 1.2 Start up the boilers with the baghouse Bypass damper open and all other dampers closed.
- 1.3 The boiler will be firing only natural gas or No. 2 fuel oil at this time. When the outlet temperature of the baghouse has stabilized above 200°F, the inlet and outlet dampers of all modules may be opened.

Outlet temperature is a better indicator of how well the baghouse has been preheated, since there will be a large temperature drop through the unit at start-up.

- 1.4 After all the module dampers have opened, the Bypass damper can be closed.
- 1.5 When the outlet temperature has stabilized at 300°F for at least one hour then coal firing may be initiated.
- 1.6 Reopen the Bypass damper before firing coal in the boiler. All module dampers may remain open.
- 1.7 When the percentage of coal to gas or fuel oil is 50% and boiler operation is stable, the Bypass damper can be closed again.

- 1.8 The pressure drop across the fabric will be very low until a dust cake is created. Do not initiate a cleaning cycle for the first twelve hours or until the pressure loss across the system reaches at least 5.0" W.G.

## 2. Conditioned Bags

- 2.1 For a seasoned fabric Item 1.1.8 may be ignored.

## C. Start Up - General Hi-Temp Applications

Baghouse start-up procedure for other Hi-temperature process applications are similar to the above procedure for coal fired boilers. This procedure should be followed as closely as possible where applicable.

Remember that new bags are most susceptible to permanent blinding at start-up. The gases may contain appreciable amounts of moisture and other condensibles and will initially be below the dew point temperature. Combustion of fuel will most likely be incomplete. Therefore, it is important to protect the fabric as much as possible until stable operation can be achieved. The following procedures are recommended:

1. If possible, start-up on Bypass, or if this is not possible precoat filter bags to protect fabric from condensibles.
2. If either of these methods, precoat and Bypass, are impractical or not available, then baghouse should be preheated by combustion gases before process dust is introduced to the system. Natural gas is the preferred combustion fuel for preheating at start-up.
3. If neither of these procedures are possible, baghouse can be preheated with Number 2 fuel oil (first choice) and/or coal assuming good combustion can be achieved. A baghouse outlet temperature of 250°F should be reached as soon as possible.

Outlet temperature is a better indicator of how well the baghouse has been preheated, since there will be a large temperature drop through the unit at start-up.

4. In any case, do not clean the fabric until stable operations (such as 100% coal firing) have been occurring for at least one to two hours. This will allow a dust cake to build on the fabric surface of the bags, on which condensation and products of incomplete combustion will be collected. These will then be cleaned off during the first cleaning cycle.



## D. Start Up - Fine Tuning

1. During initial start-up the baghouse differential pressure will be relatively low, therefore the bag cleaning system should be operating in the automatic mode. This way, cleaning will not be allowed to occur until stable operation has been achieved.
2. Do not be concerned if, during the first minutes of operation under dust load, a slight haze is evident at the stack discharge. This is due to fine particles of dust which "bleed" through the fabric filter until a dust cake forms on the bag surface.
3. Adjust the air cleaning pressure, the set point at which cleaning is initiated, the frequency and possibly the pulse duration, as explained under the "INSTALLATION" and "OPERATION" Sections of this manual (Sections III and VIII), as required to maintain pressure drop at desired level and minimize cleaning time and cleaning energy.

## E. Shutdown

There are two Shutdown conditions. One is for the entire baghouse and the other involves isolating an individual module.

1. Shutdown of the entire baghouse is accomplished by reversing the above steps for start-up.
  - 1.1 Just as in the start-up procedures, when temperature drops below the dew point, steps should be taken to adequately protect the bags. This will include bypassing filter bags, if possible.
  - 1.2 If the shutdown is only temporary, i.e. short enough so that baghouse does not cool down completely, then as flow decreases and it becomes apparent that baghouse differential pressure will not reach the set point to initiate cleaning, the cleaning system will not have to be activated manually.

This will enable a layer of dust to remain on and coat the bags prior to subsequent start-up, so that any moisture, condensation, or oily particles will not come in contact with the virgin fabric.
  - 1.3 Do not shut down the ash removal system while dust is still being removed from the bags or while there is still dust in the hopper.

- 1.4 If access into the interior of the baghouse is required, follow the procedures in E.2 below for the appropriate module or modules to be entered.
2. Shutdown of an individual module is initiated at the baghouse control panel. Refer to instructions for operation of this panel in Section VI, Item B. A single module should only be taken off-line if absolutely necessary, and returned on-line as soon as possible, since this will cause an increase in the system pressure drop and an increase in the frequency of cleaning cycles.

Read and become familiar with the Safety Instructions in Section II and II-A before isolating an individual module and in particular before opening any access doors.

- 2.1 An individual compartment is isolated by closing the isolation switch ("OPEN-AUTO-CLOSE") for the appropriate module.
- 2.2 Turn off power to the timer on the appropriate module. This is accomplished by the "ON-OFF" Switch on the timer control panel at each individual module.
- 2.3 Install padlocks on the inlet and outlet dampers of the compartment to be entered to prevent accidental opening of a damper while personnel are inside.
- 2.4 If entry into the outlet plenum is necessary, open the top door and allow the compartment to ventilate by natural draft until internal surfaces are safe to touch.
- 2.5 ABSOLUTELY DO NOT ENTER HOPPER until filter bags have been cleaned manually for two cycles and dust conveying system has cycled for one hour. Be sure hopper is empty before opening hopper access door. DEENERGIZE AND LOCK OUT POWER TO THE DUST REMOVAL SYSTEM ON THE COMPARTMENT TO BE ISOLATED.

#### F. Extended Down Time

Under circumstances where the baghouse must be off-line for extended periods of time (greater than twelve hours) the following procedures should be followed after the previously listed shutdown procedures in Item E.1 of this section to prevent damage to and extend the life of the bags.

1. Open all access doors in hoppers.
2. Run the I.D. fan to purge the entire unit for two hours.
3. Shut down fan, close hopper access doors.
4. Open all top hatch access doors in the clean air plenums.
5. Start a cleaning cycle manually and allow at least two complete cycles before stopping.
6. Remove all ash from hopper area. (Visually check ash removal from hoppers.)

After shutdown, lingering gases which are high in moisture and other condensibles, are "bottled up" inside the baghouse modules and should be purged from the system.

If it is not possible to purge the system with the I.D. fan repeat steps 1 and 4 above. Ventilate each compartment for two hours, or allow compartments to ventilate by natural draft for four hours. After ventilation repeat steps 5 and 6 above.

## X. MAINTENANCE AND TROUBLESHOOTING

All internal maintenance associated with the baghouse can be performed from the clean air side of the unit. The collector is provided with a walk-in plenum and access door to allow inspection and removal of the bags; the baghouse is provided with a platform at the walk-in plenum for inspection and maintenance of electronic controls, valves and dampers associated with the cleaning system. Refer to Section IX, "START-UP AND SHUTDOWN", for procedures to isolate individual modules.

### A. Bags

Periodic inspection of the clean air plenum and bags is required to search for evidence of accumulated dust, moisture or rust spots. If any of these items are found, it will be an indication of bag failure or operation under improper conditions.

If abrasion is evident it may be due to the following causes:

1. High velocity abrasive dust due to inadequate baffling, or reentrainment from a hopper filled beyond its normal storage capacity.
2. Bag to bag contact from misaligned bags.
3. Corroded, broken or bent bag cages.

In the case of hot gas operation, short bag life may be caused by continuous operation at temperatures above the bag material rating (500°F) and at or below acid dewpoint (250°F).

Short bag life may also be the result of overcleaning the fabric.

If, upon bag inspection, it is found that a specific row of bags has an unusually thick dust cake, this suggests that a problem exists with the solenoid actuated diaphragm valve or that particular timer output. (See Section X, "MAINTENANCE AND TROUBLESHOOTING", Items B and C for advice on troubleshooting of diaphragm and solenoid valves respectively.)

An unusual amount of dust on top of the tube plate may be indicative of a bag or bags with holes. These defective bags should be replaced and the excess dust removed before this compartment is brought back on line. Excess dust on the clean side of the module may eventually plug the clean side of the fabric and become impossible to remove by the bag cleaning system.

The bags may show evidence of blinding due to operation of the collector with gases at temperatures below the dewpoint. In the case of installation on dryers and kilns, the bags may also show evidence of soot and/or unburned oil on the bags. For either situation, the corrections must be made with the start-up procedures and operating parameters of the process equipment which feeds the baghouse.

A normal attrition of bags during the warranty period is to be expected. A log of bag replacements should be kept listing module, location within module and date on which bags were replaced.

#### B. Timer

As with most of the other components of the fabric filter, the electrical control components do not require periodic service, however it is recommended that they be inspected at frequent intervals to ascertain whether they are operating properly.

During the timer board inspection make sure that all wires are tightly connected (while power is off). If a solenoid valve does not operate, either the valve has failed or the timer output has failed. The faulty component may be found by replacing the solenoid valve with a new one and checking for proper operation. If a timer output is found to be at fault, do not attempt to repair the timer -- replace it with a new timer and send the damaged one back to the factory for repair.

Should the timer board fuse blow, do not replace it with a higher rated fuse or a slow blow fuse. The timer board is supplied with a BUSS AGC-3 250V fuse.

The inspection of the solenoid valves involves checking all connections for tightness (while power is off) and listening to the operation of the valves for one complete cycle to make sure that all valves operate properly.

#### C. Diaphragm Valves

Although these valves do not require periodic service, it is recommended that the valve operation be periodically checked for operational failure. Open failure of a diaphragm valve can be ascertained by excessive pulse air consumption (overtaxed compressor), drop in compressed air manifold pressure, or by listening for a continuous air leak beyond the valves.

Once the failure has been located, depressurize the system, remove the top bonnet of the diaphragm and proceed to check for the presence of foreign material lodged between the

diaphragm and its seal, for failure of the diaphragm proper, or for fatigued springs about the diaphragms. The valve may be rebuilt by means of a repair kit. DO NOT attempt to dismantle a valve if the system is pressurized.

Closed failure of a diaphragm valve can be verified by observing a lack of pressure drop in the manifold pressure gage when a solenoid valve is energized. The likely cause is a plugged vent tubing or solenoid valve orifice. Note that if the solenoid valve fails to energize or if the solenoid is energized but the valve fails to operate, the failure will be within the solenoid operated valve or the timer.

#### D. Solenoid Valves

As in the case of diaphragm valves, the solenoid valves do not require periodic service, however they should be periodically checked for operational failures.

The failure of solenoid valves can be in either the open or closed position. Failure in the closed position can be traced to lack of energizing signal, burnt coil, foreign matter accumulated inside, or an excessively worn plunger. Failure in the open position may be due to continuous energization, internal accumulation of foreign matter, excessive wear of the seal disc, or a worn plunger jammed in the enclosing tube.

This type of failure is easily identified once the malfunctioning valve has been located. If air is continuously vented through the solenoid valve port, the failure is in the open position; if no air flows out of the port, the failure is in the closed position.

The troubleshooting procedure requires an electrical check to insure that the signal does not latch the coil on, and that the coil is activated when the signal is received. This last item can be checked by listening for a metallic click when the timer signal is received. The timer signal check is explained under Section VI, "ELECTRICAL CONTROLS", of this manual.

If the problem is not electrical in nature, then proceed to depressurize the system and to remove the solenoid valve body for access to the plunger, spring, disc, etc. NOTE: Always valve off air supply and depressurize the air manifold before doing any maintenance on diaphragm valves and solenoids. Also, turn off power to the timer. Check for worn components and/or accumulation of foreign matter. The valve may be either replaced entirely or rebuilt by means of a repair kit.

### E. Moisture

Evidence of moisture inside the collector, such as water puddles or rust spots, may be due to condensation of water vapor or acid from hot gases, or due to infiltration from the outside in areas which were not properly sealed.

The problem of moisture due to condensation from hot gases can be due to inadequate insulation for the operating temperature, or due to shutdown of the collector with hot gases inside for long periods of time. Additional insulation or correct operating procedures will eliminate the problem.

If the problem of moisture is due to infiltration, very evident after heavy rains, visually check for traces of runoff from the walls at weld lines or flanges. Leaks from flanges or weld seams are best sealed by cleaning the area and caulking with epoxy or silicone rubber sealant. Seal welding may also be used but it requires either removal of bags or shielding the bags against welding sparks that will burn pinholes in the bag material. These pinholes are not easily seen and will enlarge very quickly during operation of the collector.

Infiltration due to leaks from access doors are usually due to improper tightening of the doors or problems with the gaskets. The problem may be checked by opening the doors and visually inspecting the gaskets. The gaskets should be firmly in place on the door coaming around the entire perimeter, with no evidence of gaps.

Damaged gaskets will require replacement. Make sure that the metal surface is properly cleaned before cementing new gaskets in place with adhesive. Any rust, corroded spots, paint, etc., left on the metal surface will lead to eventual failure of the replacement gasket.

Infiltration due to leaks around the compartment damper shafts may suggest the need to replace the shaft seals on the inlet butterfly dampers and the packing rings on the outlet poppet damper glands. In the same manner leaky seals on the poppet damper air cylinders may cause the damper to drift open when it should be closed.

### F. Baghouse Differential Pressure

As mentioned previously, system pressure drop is one of the best indicators of baghouse performance and condition. A log should be kept up to date, on a weekly basis as a minimum, and daily if possible. Therefore, trends can be studied and the need for maintenance or bag replacements can be scheduled more



effectively. Additionally, an unusual pressure drop reading can signal the need for inspection immediately, rather than waiting for the problem to escalate.

Lower than normal readings may mean a leak in the system. Check stack opacity and dust buildup on the tube plates.

Higher than normal readings could have many causes: Blinded fabric, inoperative bag cleaning system, inoperative damper, overfull hoppers or possibly just plugged tubing lines on the differential pressure gages. In either case, first try to isolate the problem to a specific module, and proceed from there.

#### G. Microprocessor Programmable Controller

1. If the Programmable Controller is not in service, the compartment inlet and outlet dampers can not be operated from the control panel. They must be manually actuated by the solenoid located at the air cylinder actuator. Remember that only the outlet damper on each module needs to be closed during cleaning.
2. A single, 4-way, dual solenoid valve operates each damper. Pushbuttons are located on the side of each solenoid that allow manual operation of the damper.
3. If the controller is out of service for more than six hours or system pressure drop reaches 6", whichever occurs first, it will be necessary to manually initiate a cleaning cycle.

Proceed as follows:

- 3.1 Close the outlet damper on the module to be cleaned.
- 3.2 Jumper the "pressure switch" terminals located on the N.C.C. timer of the module to be cleaned.
- 3.3 Allow the cleaning cycle to continue for four minutes.
- 3.4 Remove the jumper and reopen the outlet dampers.
- 3.5 Repeat procedures (3.1 through 3.4) for all modules.
- 3.6 The baghouse should be cleaned in this manner twice a day, or as required by excessive pressure drop, until the controller is back in service.

CAUTION: Timers should be switched off while jumpering. DO NOT leave jumper on the timers.

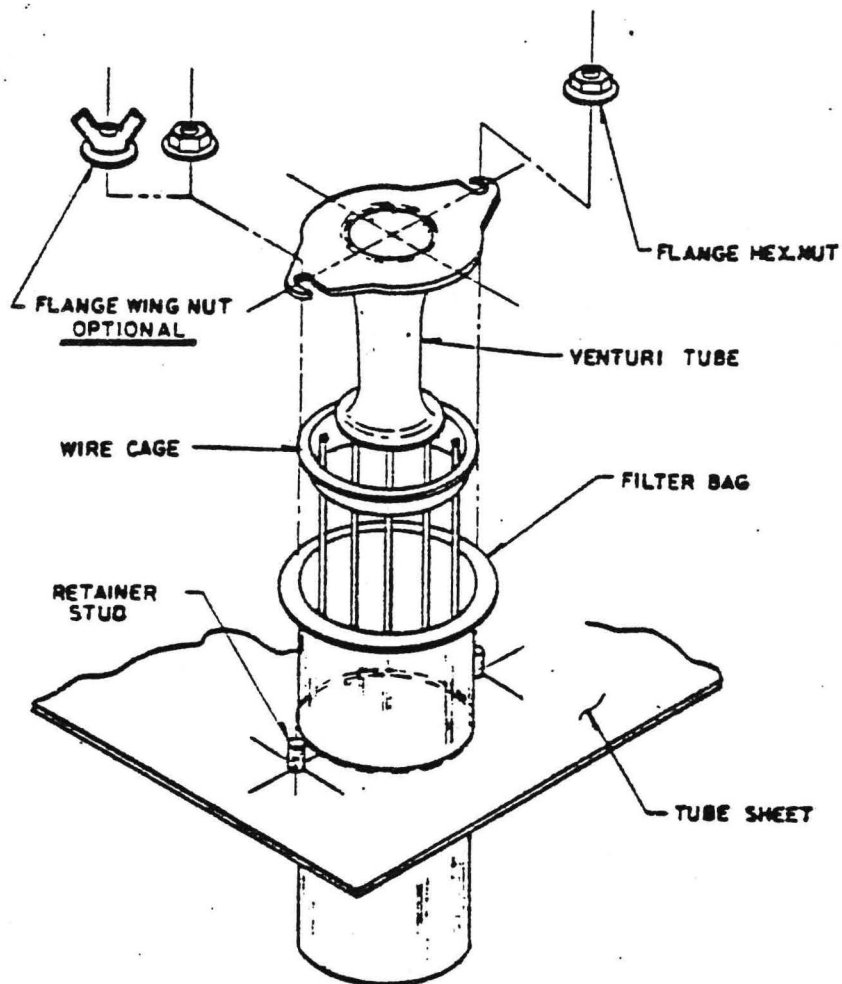
CAUTION: Make sure that the doors for the timer enclosures are closed sufficiently to keep rain or snow out.

#### H. FILTER BAG INSTALLATION PROCEDURE

Correct installation is essential in obtaining good performance from and long life of the filter bags. Special care must be taken in handling both the bags and cages. Torn threads on the fabric or bent cages can lead to premature bag failures and excessive emissions. The following recommended procedures have proven effective in improving bag life while reducing installation time. Refer to the attached installation sketches.

1. Filter bags are folded, wrapped in plastic and usually shipped in boxes of 12. These boxes should be stored in a weather protected enclosure at the site. Just prior to installation, these boxes should be transported inside the walk-in plenums and laid on the tube plate floor on wooden planks. Additional planking should be used over the studs inside the plenum. This will provide a more comfortable walking surface and prevent damage from foot traffic to the tops of the bags which have been installed.
2. The filter bags are first inserted into the tube plate holes. The correct procedure involves stuffing the bag through the hole without unfolding it. The bag must first be rolled into a shape that will minimize contact between the fabric and the tube plate while the bag is guided through the opening. Once inserted, gravity will allow the body of the bag to unfold downward while the flange at the top seats against the tube plate. The top flange of the bag should be given a shake, causing the seam of the bag to align itself vertically; however, contact with the edge of the hole must be kept to a minimum. Any bag that is torn or appears damaged should be discarded. Foot traffic on top flanges of the bags should be avoided as much as possible.
3. Next, insert the cages into the filter bags. Cages which are bent or broken should be discarded. Cages must not be twisted as they are pushed into the bags. It is normal for the fit between the bags and cages to be tight. Any cages which fall into the bag without assistance is evidence of an oversized bag. This bag should be removed. If it is difficult to get the bottom of the cage started into the bag, the cage should be rocked toward the seam to allow the bottom of the cap to clear the cuff in the area of this seam, then rocked backward to get the cage started into the cuff. Under no circumstances are the cages to be twisted or rotated because this will damage the top and twist the

vertical seam on the bag. If the top flange of the bag is pushed through the hole in the tube plate, it should be discarded and replaced. If the fit between the bag and cage is too tight, such that reasonable force will not allow for complete assembly of the cage into the bag, the cage should be pulled out and the bag discarded. Cages must be pushed all the way into the bags and the top flange of the cage must make contact with the top flange of the bags. If this is not possible, the filter bags are too short and should be discarded and replaced.



**ENVIRONMENTAL  
ELEMENTS  
CORPORATION**  
Subsidiary of Koppers Company, Inc.

M.O. NO.

**FILTER BAG  
ARRANGEMENT**

DRAWN *AD/RWT*

SIZE

**A**

FSCM. NO.

DRAWING NO.

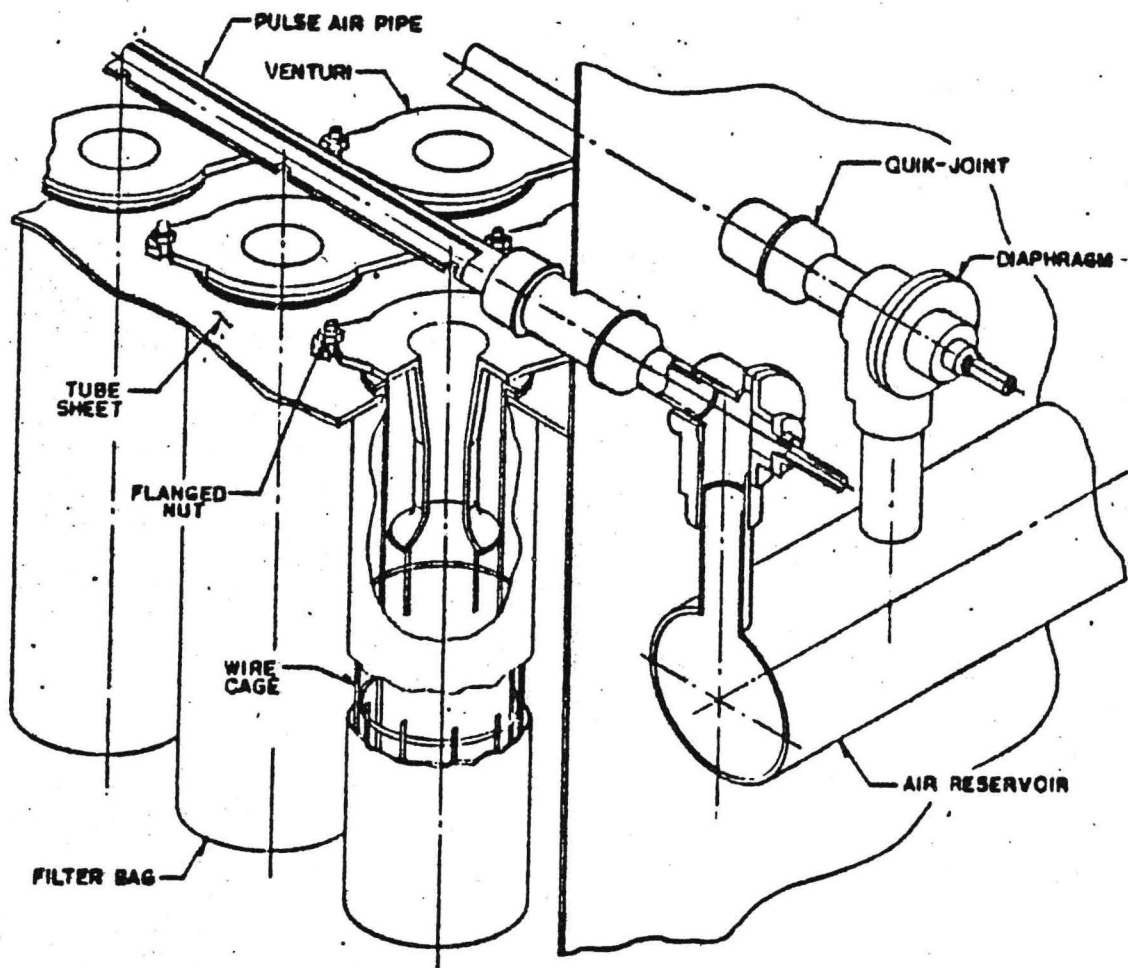
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REV.

DATE **3-05-83**

SCALE

SHEET



<b>ENVIRONMENTAL ELEMENTS CORPORATION</b> Subsidiary of Koppers Company, Inc.		M.O. NO.		PULSE AIR ARRANGEMENT	
		SIZE <b>A</b>	FSCM. NO.	DRAWING NO. <b>1307</b>	REV.
DRAWN <i>MD/RWT</i>					
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